Diamond and Silicon Carbide at the Ries and Popigai impact craters. R. M. Hough[1], Masaitis V.L[2], Gilmour I[1], and Pillinger C.T[1]. [1]Planetary Sciences Research Institute, The Open University, Walton Hall, Milton Keynes, MK76AA, UK. [2]Karpinsky Geological Institute, St Petersburg, 199026, Russia.
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Abstract Large silicon carbide grains (300mm in size) and fine grained skeletal diamond aggregates (10mm) have been found in the diamond bearing residues of impactites from the Popigai impact crater in Russia. These occurences are very similar to those found in the suevite at the Ries crater in Germany and are attributed to a process similar to chemical vapor deposition in the impact produced fireball.

Diamonds up to 300mm in size have been found in Suevite (polymict impact melt breccia) from the Ries impact crater in Germany [1, 2]. Very similar diamonds in both colour and form are well known to occur in impactites from the Popigai impact crater in Russia [3] (typically up to 500mm in size and rarely up to 1-5mm). The diamonds from Popigai are polycrystalline aggregates of cubic diamond but which also contain lonsdaleite, the hexagonal polytype of diamond (typically 0 to 20% of the aggregate but up to 70% in some cases [4]). The Ries diamonds are also polycrystalline aggregates of cubic diamond. They have been reported to contain lonsdaleite (up to 20%) [1] but in another study only a trace at most was identified [2]. The presence of lonsdaleite in these diamonds and their pseudo-hexagonal morphologies has been used to propose a shock origin by direct transformation of the graphite source [3].

The acid resistant residue of the Ries suevite also contained blue/green silicon carbide grains and fine dark cindery fragments. A transmission electron microscope study (TEM) of the fines found them to be composed of diamond and silicon carbide with one grain displaying a homo-epitaxial intergrowth of the two minerals [2]. These occurrences and especially the intergrowth led to an interpretation of a growth mechanism for the two minerals similar to chemical vapor deposition (CVD) in an impact produced fireball [2].

If a CVD type mechanism is responsible for the fine diamond and silicon carbide found in the bulk sample of Ries suevite then it should also be responsible for the formation of such minerals at other impact sites. The diamond occurrences in impact derived lithologies from Popigai have been extensively studied by Russian scientists using extraction techniques involving alkalis and sieves. Their lowest detection limit of 70mm excludes them from identifying the presence (if any) of the fine dark cindery diamonds and silicon carbide observed in the Ries samples by [2]. Although no report of silicon carbide from Popigai has previously been published in English or seen in translations of the Russian literature it is present at Popigai. One of us (V.M) has provided grains of silicon carbide extracted from Popigai impactites. They were found in the residues which contained diamonds, the silicon carbide grains are bluish/green in colour and typically 100-300mm in size and optically very similar to those found in the Ries suevite.

With the knowledge that silicon carbide is present at Popigai we endeavoured to search for the fine grained diamond and silicon carbide thought to be indicative of the CVD type process as reported at the Ries [2]. An aliquot from the Popigai diamond-bearing impactite residue was suspended in water and pipetted onto a carbon coated copper grid for study in the TEM (Jeol 2000FX). Fine grained material was observed, and the grains were in the form of skeletal aggregates very similar to those described by [2] for those from Ries. They were polycrystalline aggregates (up to 10mm in size) and composed of pure carbon as identified by the EDS, the selected area electron diffraction pattern (SAED) indicates it is almost entirely cubic diamond. The SAED patterns obtained across the aggregates showed no evidence for lonsdaleite but occasionally a faint hint of graphite could be observed by the presence of spots with an inter-atomic distance (d-spacing) of 3.36Å.

The presence of silicon carbide and some fine grained skeletal diamond aggregates in impactite from Popigai, the occurrence of which is very similar to those reported by [2], is interpreted to represent formation by a growth mechanism similar to CVD (as proposed for the Ries by [2]). This provides further evidence for CVD as a formation process for diamond and silicon carbide within impact produced fireballs.

References

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